

DESCRIPTION AND LIFE HISTORY OF A NEW WESTERN AUSTRALIAN COCCID.

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(Nineteen Text-figures and one Map.)

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I. INTRODUCTION.

In September, 1945, it was brought to the notice of the Department of Biology, University of Western Australia, that an infestation of Coccid galls was seriously hampering the establishment of Tuart (*Eucalyptus gomphocephala*) plantations on Rottnest Island.

Since the Tuart gall is exceptionally rare on the mainland, it was suggested that the reason for the unduly large population of Coccid galls on Rottnest Island might lie in the fact that parasitoids of the Coccid were either not present or not proving a limiting factor. Accordingly, an investigation was undertaken to explore the possibilities of biological control of the Coccid pest through the introduction to the island of a parasitoid or of parasitoids. It was obvious that the first step in such an investigation should be a research into the ecology of the gall in order to determine the effect of natural enemies; and that basic to this ecological enquiry would lie an investigation into the general morphology and life history of the insect.

This paper, then, represents an attempt to establish a basis for the above investigation. The Coccid proved to be a new species of the genus *Apiomorpha* Rübs. (*Brachyscelis* Schrader).

II. HISTORICAL.

The genus *Brachyscelis* was established by Schrader in 1863. Schrader (1863*b*, p. 6) defined it as follows:

"Genus *Brachyscelis*. Where the females have six legs complete, but short, and unfit for use."

Schrader shortly afterwards (1863*c*) discussed the subject further and described five specimens taken in the neighbourhood of Sydney.

In 1894, C. H. Rübsaamen re-established the genus as *Apiomorpha*, stating the characters as follows:

"Adult females pear shaped, the abdomen tapering, and ending in two strongly chitinous tubercles. Mouth parts small, more or less atrophied. Feet and antennae present in all stages but more or less atrophied in adult. Anal ring with six hairs. Inhabiting woody galls of characteristic shapes, whose growth at the expense of their host they cause and direct.

"Larvae ovate and segmented; abdomen ending in two suppressed tubercles each bearing a long seta. Margin of body surrounded with fringe of uniform acuminate spines, each of which bears for a little while after birth, on either side, thin, hyaline, wing-like appendages; each species apparently bearing the same number. Males undergoing their transformation in separate cylindrical galls."

This writer described and figured five species of the genus.

The new species conforms with the characters stated by Rübsaamen with the exception of the wing-like appendages of the larva, the presence of which I did not detect, and the more or less atrophied mouth parts. This, I believe, may be due to the fact that in the Coccidae the stylets may be withdrawn from the plant and looped within the body, thus not being visible externally.

A great deal of our knowledge of the genus *Apiomorpha* is due to the work of W. W. Froggatt. His first paper on this subject appeared in 1892.

In 1893, J. G. Tepper proposed a new classification for the family Brachyscelidae and described new species in a paper which was severely criticized by Froggatt the following year.

Between 1893 and 1898, Froggatt published four papers on the family Brachyscelidae with descriptions of new species.

C. Fuller (1896 and 1897) described new species in the *Agricultural Gazette of New South Wales* and in the *Journal of the West Australian Bureau of Agriculture*. In 1899 he published an amplification of these papers, and described another new species.

Three more species were added to the genus in 1921 with Froggatt's "Descriptive Catalogue of the Coccidae of Australia". In the years 1929 and 1930, this writer published two further papers on gall-making Coccidae in which he described six new species of *Apiomorpha*.

Froggatt's work culminated in 1931 with his "Classification of Gall-making Coccids of the Genus *Apiomorpha*". This classification I have followed in making my determination of the new species.

III. SYSTEMATIC POSITION.

The classification of Froggatt is based upon the structure of the female galls, the arrangement of the hairs (setae) and spines on the dorsal surface of the female, and the form of the anal appendages.

Froggatt separates the species of *Apiomorpha* into nine groups, of which the new species herein described clearly falls into his Group D, defined as follows:

"Galls oval, smooth or fluted, sessile, apical orifice small circular. Normally produced upon the branchlets, but often growing out of flower buds. Coccid with the dorsal surface covered with scattered thorn-shaped spines. Anal segment longer than broad, anal appendages coalescing with anal segment, which is broad at the base, round and rugose at the sides, and with the anal appendages forms a lance-shaped tip which is slightly bifid."

The new species conforms with all the above characters with the minor exception that it has never been observed growing out of flower buds.

Within this Group, the new species shows many features of likeness with *Apiomorpha ovicola* (Schrader, 1863a). As with this species, the whole body surface is clothed with long attenuated hairs. Also, dorsally, the central areas of the cephalic and thoracic segments are covered with curved thorn-shaped spines. However, with *A. ovicola*, the fourth to sixth abdominal segments are, according to Froggatt, covered with these spines; whereas the new species shows on the third to fifth abdominal segments but one row of spines on the posterior margin of the segment together with several scattered spines. The sixth abdominal segment of the new species possesses a semicirclet of spines on its posterior margin and several (often but two) medially-placed spines.

The anal region differs also in that the anal segment is longer and the anal appendages but very slightly bifid; thus this segment plus its appendages exhibits a much more slender shape than is the case with *A. ovicola* as figured by Schrader (1863a) and Froggatt (1931).

With reference to the shape of the female gall, this shows a marked similarity to that of *A. glabra* described and figured by Tepper (1893); and Fuller (1899) reports having seen *A. glabra* in Western Australia.

Tepper's (1893) description of this species is as follows:

"Female Gall. Solitary, sessile, considerably projecting beyond point of attachment posteriorly, ovate, nearly smooth, faintly striated longitudinally, and sometimes with irregular, smooth warts (male galls?), whitish or grey, clouded with brown; apex rounded, aperture very minute; cavity rather large, corresponding in form with external shape. Insect not known, nor male galls.

"Length, 28 mm.; diameter over attachment, 15 mm.; at apex, 3.5 mm.

"Habitat—Mount Lofty Ranges, Lyndoch, etc. On stout branches of *Eucalyptus rostrata*, but rather rare and always solitary. The outer texture resembles that of the bark of the branches very closely."

There is obviously a stronger possibility that the new species described is Tepper's *A. glabra*, but since he has described neither the female insect nor the male gall, his species cannot be regarded as valid.

Froggatt (1893), however, states that he considers *A. glabra* an abnormal form of *A. ovicola*. The shape of the gall figured in this paper is typical of some five hundred examined on Rottnest Island and ten collected upon the mainland—always upon *Eucalyptus gomphocephala*. Hence it would appear that this is no mere abnormality, but the normal form of the gall of the species, and the gall of the new species is much more elongate than that figured by Schrader (1863a) for *A. ovicola*.

To the remaining species of Froggatt's Group D, *A. helmsi* (Fuller), *A. withersi* (Frogg.) and *A. floralis* (Frogg.), the new species shows no close resemblance.

The Coccid described in this paper, then, cannot be referred to any species yet described. The new species, *Apiomorpha egeria*, is therefore erected for its reception.

Types, male and female, and male and female galls, have been placed in the Australian Museum, Sydney, New South Wales.

IV. DESCRIPTION OF MALE AND FEMALE IMAGOS AND GALLS.

APIOMORPHA EGERIA, n. sp.

In the following descriptions, measurements refer to type specimens only and their exact values have no specific significance.

Male Imago. Figs. A-F.

Length, body (to extremity of genital sheath) 2.55 mm. Length, forewing 2 mm.

Colour: Chiefly bright yellow; ocelli deep purple.

Forewings whitish and opaque; haltere light brown; genital sheath light brown.

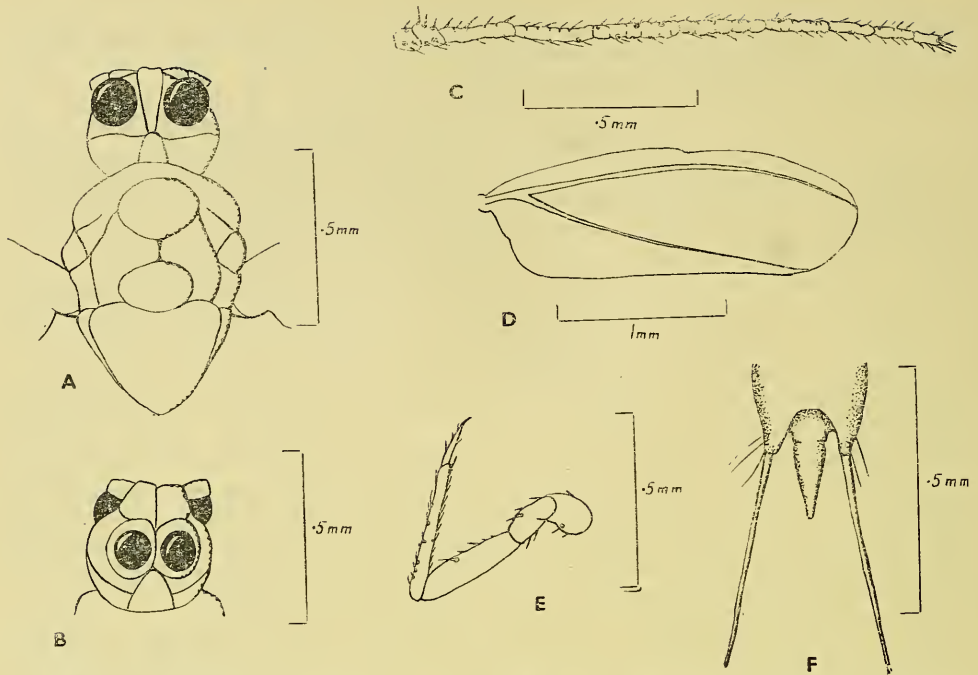
Head globular, narrower than prothorax with four large ocelli.

Antennae (length 1.57 mm.) 10-jointed, these joints being neither distinct nor regular, two basal segments globular, and approximately equal in size; third, fourth, fifth and sixth segments elongate, and thrice the length of basal segment; seventh, eighth, ninth and tenth segments decreasing in size in this order, eighth segment being twice length of basal segment; all segments with numerous small setae, apical segment surmounted by circlet of large setae.

Forewings membranous, showing veins R and M, and possessing a uniform covering of microtrichia; halteres minute, slender, method of attachment to pocket of forewing indiscernible.

Legs: Coxa globular; trochanter elongate showing suggestion of division, length of coxa in relation to trochanter with proportion 2:3; femur stout, twice length of trochanter; elongate slender tibia with length in relation to trochanter with proportion 5:3; tibia with small apical spur; slender, single-clawed, tarsus, approximately one-third of length of tibia; all segments with numerous small setae.

Terminal abdominal segment with two lateral lobes each bearing an elongate white filament (length 3.4 mm.), genital sheath slender, conical.



Figs. A-F.—*Apiomorpha egeria*, n. sp. A. Head and thorax of male imago, dorsal view. B. Head of male imago, ventral view. C. Left antenna of male imago. D. Forewing, male imago. E. Right mesothoracic leg of male imago. F. Eighth abdominal segment and aedeagus sheath of male imago, dorsal view.

Female Imago. Figs. G-K.

Length, body 2.43 cm.; maximum body width 1.32 cm.; shape turbinate; integument covered with scattered attenuated setae; body covered with white mealy secretion; integument membranous; antennae, legs and spiracles chitinized, anal appendages strongly chitinized.

Colour: body uniformly creamish-brown; antennae light brown; pro-, meso- and meta-thoracic legs red-brown with colour deepening in this order; colouration of individual leg lightest at basal segment, darkening towards apex; spiracles red-brown and anal appendages a very dark brown; setae of integument light brown and spines a deep red-brown.

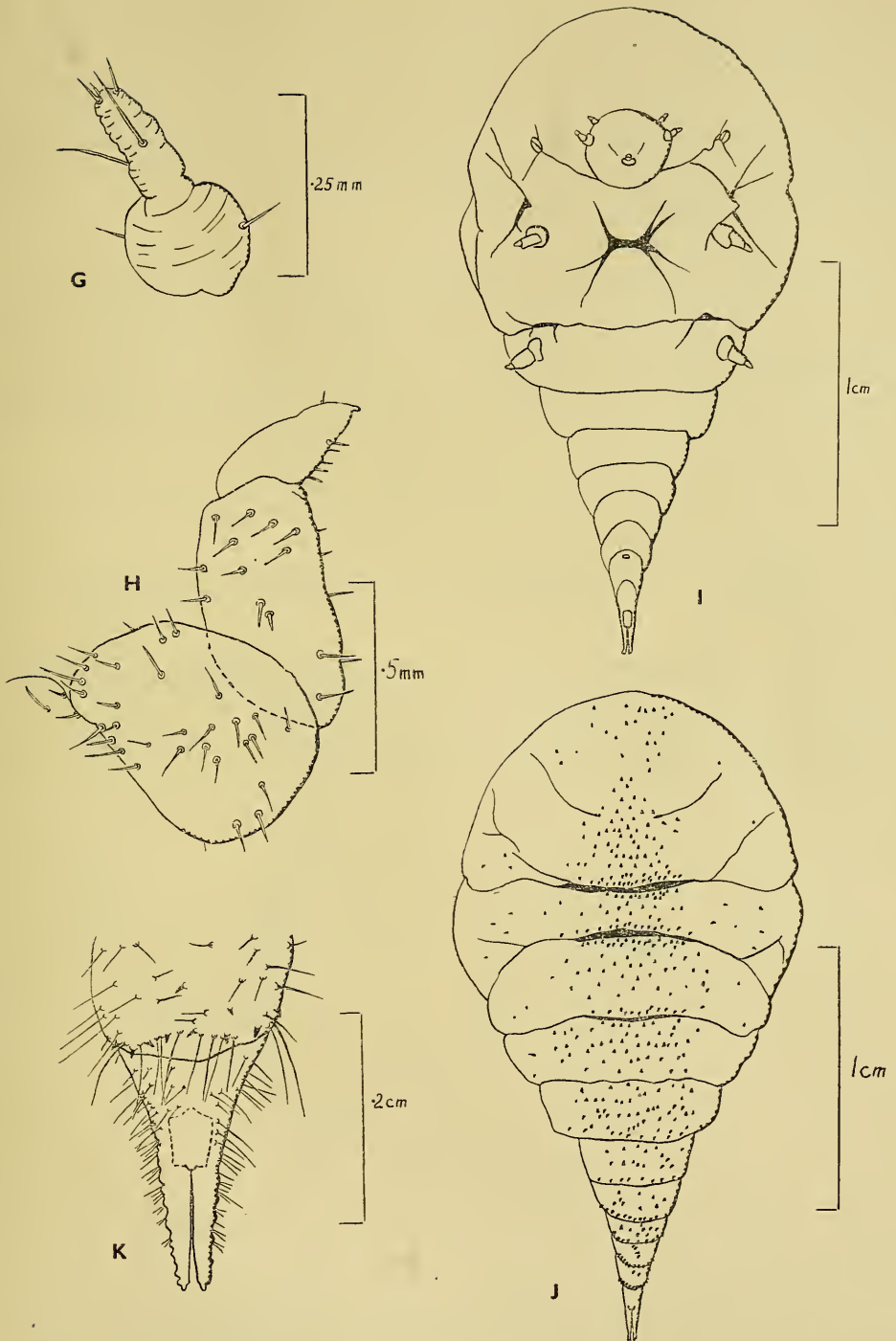
In this description, I think it preferable to reverse the usual procedure and describe the ventral surface before the dorsal in order that attention may be concentrated on the taxonomic details of the dorsum.

Venter.—Head coalesced with first two thoracic segments; eyes absent; antennae two-segmented, basal segment broad, globular and shorter than wide; apical segment more elongated, twice length of basal segment, cylindrical, annulated, rounded at apex and surmounted by a circlet of setae; mouth a small circular aperture situated on a convex circular area of integument; mouth parts always looped within body when insect examined; labium minute, semi-circular, one-jointed.

Prothoracic leg, three-segmented, basal segment squat, much broader than long, second segment large, width one-half of basal segment, but longer than this segment; apical segment bluntly conical, length approximately half that of basal segment; apex annulated and bearing a small, medially-directed claw.

Head plus first thoracic segment separated from mesothorax by a deep median cleft, terminating at the level of and anterior to the mesothoracic spiracles.

Mesothorax very broad with a deep infolding of integument in centre; mesothoracic leg having same proportion as prothoracic leg, but larger, more heavily chitinized.



Figs. G-K.—*Apiomorpha egeria*, n. sp. G. Left antenna of female imago. H. Right mesothoracic leg of female imago. I. Female imago, ventral view. J. Female imago, dorsal view. K. Anal appendages of female imago, dorsal view.

Metathorax sharply demarcated from fused cephalic and pro- and mesothoracic segments by a deep intersegmental fold in which are situated the metathoracic spiracles. Metathoracic legs similar in proportion to mesothoracic, larger, more heavily chitinized.

Abdominal segments distinct, seven in number, tapering in width, length of segments relatively constant; aperture of vagina in median anterior position on sixth abdominal segment; seventh segment (anal) long, narrow, tapering, coalesced with base of anal appendages, somewhat rugose, carrying short, fine setae springing from small bosses; fringed anal ring situated mid-ventrally; anal appendages long, slender, markedly rugose, with tips but slightly bifid. Abdominal spiracles absent.

Dorsum.—Proportion of segments as for venter, but pro-, meso- and metathoracic segments distinctly marked by means of deep median intersegmental clefts.

Median surface of head and of thoracic regions covered with enlarged, red-brown, thorn-shaped spines (the rose-shaped thorns of Froggatt), which have a much greater density in the intersegmental regions; first and second abdominal segments possessing uniform bands of spines extending almost across the dorsal surface; third, fourth and fifth abdominal segments possessing a row of spines across their posterior margin, together with several scattered spines; sixth abdominal segment with semicircle of spines on its posterior margin, and several (often two) medially placed spines; anal segment entirely lacking spines, but setose especially laterally.

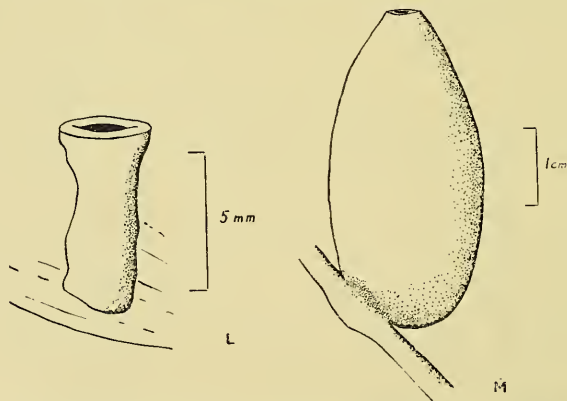
The third instar female immediately following completion of the second ecdysis shows considerable differences in size and proportion in comparison to the gravid female. Length 0.95 cm. Width 0.49 cm.

It is notable that the female of this earlier period of the third instar shows integumentary setae in much greater density than was the case with the gravid female.

The Male Gall. Fig. L.

Small, length 0.8 cm., width 0.3 cm.; with general cylindrical shape and dilated apex; colour predominantly purplish in younger stages before apex opens, later becomes green, although young stages sometimes exhibit a green colouration.

Generally situated on adaxial surface of leaves, but may be found on abaxial surface, on branchlets, and rarely on the sides of the female gall.



Figs. L-M.—*Apiomorpha egeria*, n. sp. L. Male gall. M. Female gall.

The Female Gall. Fig. M.

Although the female galls on Rottnest Island are distinctly gregarious, it would appear that this is but a result of undue numbers; on the mainland, galls are solitary.

Length 4 cm., width 2 cm.; gall sessile, ovate, smooth, green (this colour tending to brown with age); apex slightly depressed with a small circular orifice; wall of gall consisting of two distinct regions, the outer thick and spongy and the inner hard and thin; situated on branchlets, or, rarely, on stem.

V. IMMATURE STAGES.

Larva—First Instar. Figs. N, O.

At this stage it was not possible to differentiate between male and female.

Length (exclusive of antennae and terminal setae), 0.4 mm. Width (exclusive of supra-marginal setae), 0.25 mm.

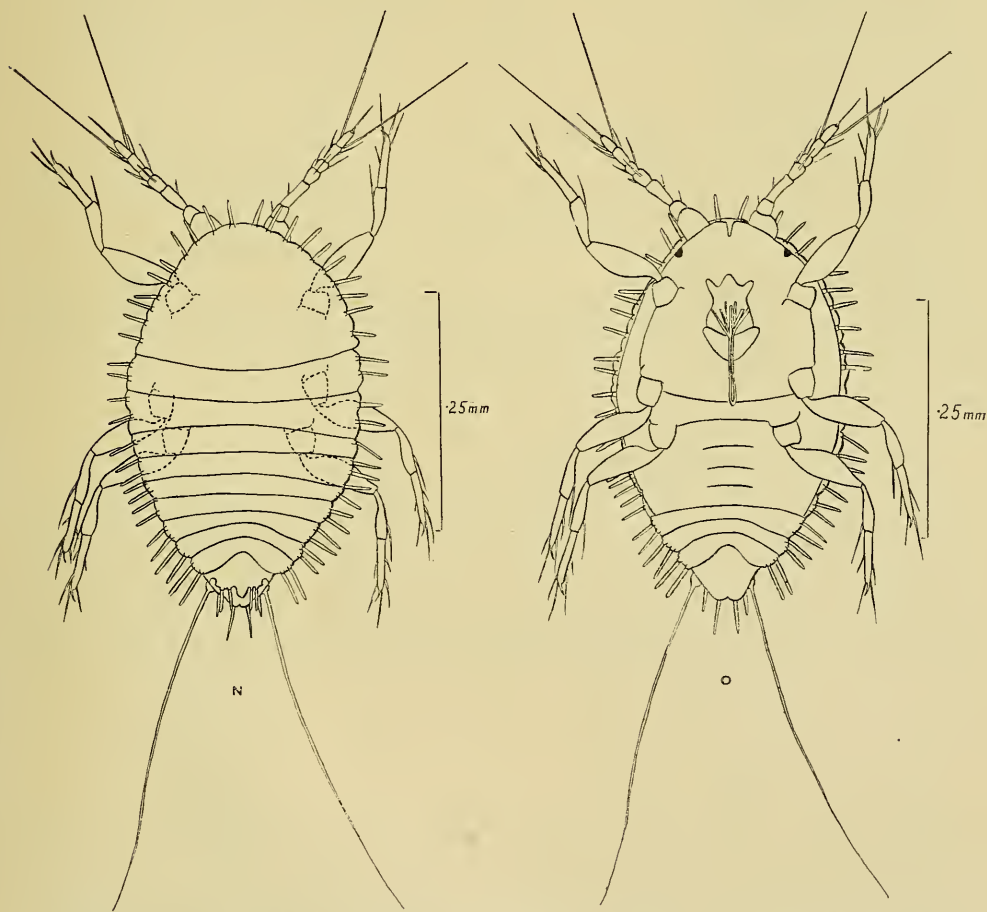
Form oval; dorsum slightly convex; colour yellow with black ocelli.

Dorsum.—Head fused with prothorax; meso- and metathoracic segments distinct; seven abdominal segments demarcated and a highly modified apical segment bearing four setae; body surrounded by fifty-eight marginal setae; apical segment bears dorso-laterally two greatly-elongated terminal setae, approximately equal in length to the body.

Venter.—Deep cephalic notch situated antero-medially; head, pro- and mesothorax appear as fused, metathorax distinct; abdominal segments distinct, but with first four abdominal segments, the intersegmental suture is only visible medially.

Ocelli-black, situated antero-laterally.

Mouth parts of typical form; maxillary and mandibular stylets elongated and thread-like; beak apparently one-segmented, stout conical; framework of mouth parts large and placed between prothoracic legs.



Figs. N-O.—*Apiomorpha egeria*, n. sp. N. Larva, dorsal view. O. Larva, ventral view.

Male, Second Instar. Fig. P.

Body colour white; setae light brown; ocelli black. Length (excluding setae at apex of abdomen) 1.02 mm. Width 0.56 mm.

Dorsum.—Head semi-circular and fused with prothorax; two ocelli present; meso- and metathoracic segments broad and flattened.

Abdomen consisting of eight segments tapering to small trilobed apical segment; fifth and sixth abdominal segments bearing dorso-laterally a pair of enlarged setae of length equal to half that of segment, seventh abdominal segment with two pairs of setae more medially placed; each lateral lobe of eighth segment bearing a seta equal in length to the three posterior abdominal segments and elongated in the antero-posterior axis, a pair of small setae medially convergent with those of the corresponding lobe, together with several laterally placed setae; median lobe probably representing the genital sheath visible in the imago enclosing the aedeagus.

Venter.—Head and prothorax appear as fused; antennae visible as small blunt antero-lateral elevations; prothoracic legs indistinctly four-segmented, consisting of squat basal segment, and two quadrate segments followed by an elongate, conical, apical segment, of the same length as the three previous segments and surmounted by two short setae; mouth situated on circular elevation consisting of a posterior crescentic labium and a smaller anterior labrum.

Meso- and metathoracic segments distinct, with legs having same proportion as those of prothorax but larger.

Eighth abdominal segment as for dorsum, but median lobe more prominent from ventral view.

Male Propupa. Fig. Q.

Length, body 2.04 mm. Width, body 0.68 mm.

Colour: Uniform pale yellow.

Head globular, indistinct from prothorax; antennae short, stout, non-segmented, curved beneath body to base of prothoracic leg.

Meso- and metathorax indistinctly separated; forewing sheaths prominent, stout; legs indistinctly four-segmented.

Abdomen 8-segmented, apical segment consisting of two lateral lobes each bearing an enlarged elongate seta approximately equal in length to the eighth abdominal segment, and the medially-situated genital sheath (visible only ventrally).

Male Pupa. Fig. R.

Length, body 2.28 mm. Width, body 0.8 mm.

Colour: Pale yellow, ocelli dull black.

Head distinct from thorax and showing dorsal and ventral ocelli; antennae long, curved beneath thorax, apex free, indistinctly ten-jointed.

Prothorax distinct, meso- and metathorax fused; forewing sheaths large, distinct; legs indistinctly four-segmented.

Abdomen eight-segmented, each segment dorsally bearing a row of setae along its posterior margin; eighth segment consisting mainly of the two lateral lobes each bearing an enlarged elongate seta of approximately the same length as this segment and a stoutly conical genital sheath.

Female, Second Instar. Fig. S.

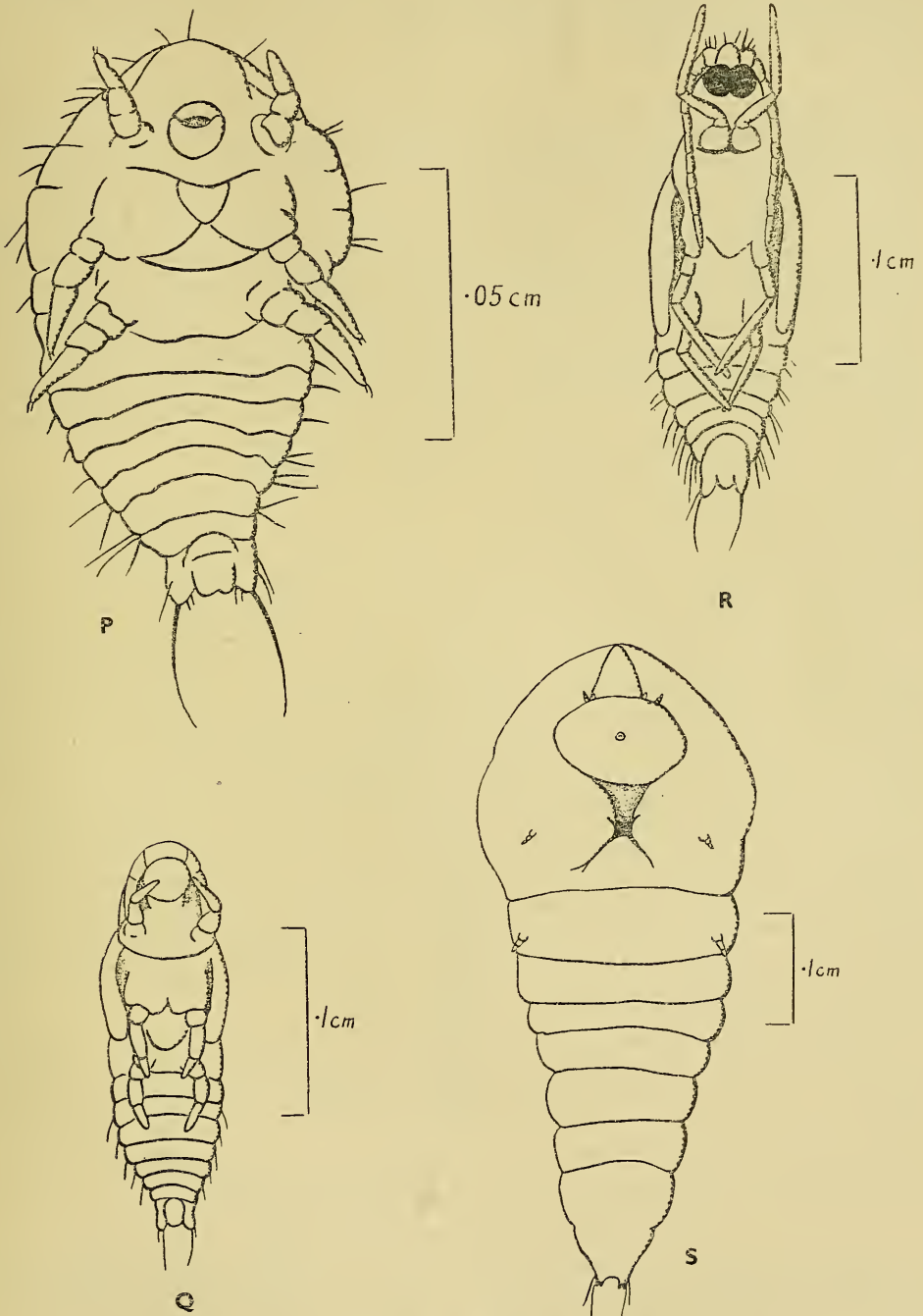
Length, 0.54 cm.; width, 0.23 cm.

Turbinate in outline.

Body colour white; legs light brown; antennae white; body very lightly covered with light brown setae; spines dark brown.

Dorsum.—Head and prothorax fused into a rounded conical mass. Meso- and metathoracic segments distinct. Seven abdominal segments visible gradually tapering posteriorly, the sixth being bluntly conical in form and the seventh crescentic, both with apices directed posteriorly; fifth and sixth abdominal segments each bearing a pair of posteriorly-projecting spines; seventh segment terminating in two tubercles, each of which bears two spines; at the base of each tubercle arises a seta of length approximately thrice that of the spines.

Venter.—Head, pro- and mesothorax appear as fused; metathorax distinct; first five abdominal segments distinct, sixth and seventh abdominal segments indistinctly separated.



Figs. P-S.—*Apiomorpha egeria*, n. sp. P. Male, second instar, ventral view. Q. Male propupa, ventral view. R. Male pupa, ventral view. S. Female, second instar, ventral view.

Antennae two-segmented, minute. Legs three-segmented, small, increasing in size in series prothorax, mesothorax, metathorax. Mouth situated on raised elliptical fold, anterior to which there is situated a triangular elevation, beginning at the base of the antennae and prothoracic legs, and with apex directed anteriorly. In the mesothoracic region the meeting of two large lateral folds of the integument with a small anterior and a small posterior fold, causes a deep median cleft.

VI. LIFE HISTORY.

The emergence of the larvae from the small circular orifice at the apex of the gall was observed to commence in the month of October, and to last for several days with the individual gall, this emergence being accelerated by sunlight. Emergence of larvae from the galls studied at Rottnest Island continued until late in the month of December.

A. egeria was found to be viviparous, the larvae emerging in an adhering chain, each larva being covered by a delicate, transparent hatching membrane (Weber, 1930, p. 356). Some seconds after emergence, the larvae shed this membrane and remained for several minutes in a semi-dormant condition at the base of the gall, the interior of which appeared to be a writhing mass of larvae. They then left the gall and travelled rapidly over the surface and along the branchlets to the growing tips. It is of interest to note the observation of Davidson* on aphids, that the cell sap of the young growing tissue of the host plant is of a very definitely higher nutritive value as food than the older tissues. This, together with the soft nature of the growing parts, will explain the preference of the *Apiomorpha* larvae for the younger plant tissues.

Those which are apparently male larvae took up position on the leaves and appeared to flatten themselves into, and adhere to, the surface of the leaf. The same process has been observed with the female larvae on the branchlets. At this stage, apparently, irritation, resulting from the larvae feeding, caused the galls to commence growth. The botanical aspect of these remarkable objects is admirably described by E. Küster (1937).

The estimation of instar duration was most difficult, the insects being continuously encased in their dense galls. Also the period of duration of the instar appeared to be most irregular, depending seemingly on the rate of growth of the gall. The first instar in both male and female was found to be generally of some ten weeks' duration, though often longer; the second instar duration of the female was observed to be some eight weeks, as was the duration of the second, prepupal and pupal instars of the male collectively. The male imagos first emerged around the 9th February, but were not observed in any numbers until later in this month. The male galls become open at the apex to allow the emergence of the male imago, this process occurring with the abdominal region foremost, and the forewings extended over the head. Fluttering its wings in short spasms, the male flies but feebly and for the most part makes its way to the female gall by crawling fairly rapidly over the branchlets. Impregnation of the female has been observed to occur through the apical orifice of the gall; and soon after the act of impregnation the males apparently die, for when kept in glass tubes males were observed rarely to live for more than one day.

The difference in the duration of the life cycle of the male and female insects is most marked. Since the final instar of the female lasts from February to October-November, the life cycle is annual, but the cycle of the male is of five months' duration only.

The death of the female imago was noted to occur after the emergence of the larvae, the female being left a shapeless mass of derm at the base of the gall.

VII. NOTE ON THE ECOLOGY OF THE GALL.

As has been noted previously, *Apiomorpha egeria* has only been observed parasitizing *Eucalyptus gomphocephala*. It would appear possible that this Coccid is confined to but one species of Eucalypt, this surmise being supported by a survey conducted over the major regions of the Tuart forest of Western Australia.

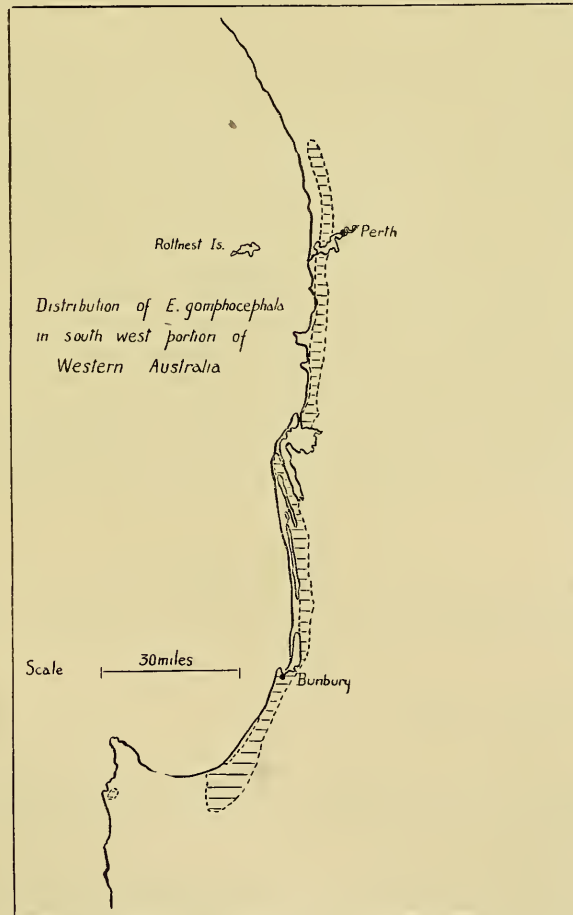
* Quoted by Imms, A. D., 1931, Recent Advances in Entomology, p. 210.

Gardner (1942) states that the Tuart forest: "is a type of savannah forest in which the trees of the Tuart (*E. gomphocephala*), attaining a height of 40 metres, dominate the forest in almost pure strands, being only rarely associated with such species as *E. calophylla* and *E. cornuata*. It is edaphically confined to the littoral limestone of the Western coastal plain, the range of the species extending from near the Hill River to the Sabina River near Busselton. It is only in the southern part of its range, where the summer (November–April) rainfall exceeds 125 mm. that it attains to the proportions of a forest in its species."

The Tuarts of Rottnest Island are an introduced flora. A map showing the distribution of *E. gomphocephala* in Western Australia accompanies this paper (see Map 1).

The galls of *Apiomorpha egeria*, n. sp., seldom occur on the mainland, and those few taken, both male and female, are, with rare exceptions, heavily parasitized, the main parasite of the female being an Encyrtid Chalcidoid. By contrast, the population of galls upon the Tuart plantation of Rottnest Island is most dense; both female and male Coccids were observed to be extensively parasitized on this island, but apparently not to a sufficient extent to be a factor controlling their undue numbers. The Encyrtid Chalcidoid is absent from Rottnest Island.

Several other species of insects are found associated with the galls, probably as inquilines; these, together with parasitoids, furnishing an extensive ecological complex.



Map 1.—South-west portion of Western Australia showing distribution of *Eucalyptus gomphocephala*.

The action of a species of Chalcidoid (possibly an inquiline) on the tissue of the gall is such as to cause small tubercles to develop on the surface, and frequently greatly to distort the shape of the gall.

Upon the death of the female due to natural causes or otherwise, the gall is found inhabited by Araneida, by small Formicid colonies or by a species of mould.

As was noted in the introduction, it is proposed to deal in detail with the ecology of the gall of *Apiomorpha egeria* in a later paper.

VIII. METHODS.

In order to determine the arrangement of the setae and spines on the dorsal surface of the integument, I have followed the method described by Froggatt (1931) in boiling the female Coccid in 10% caustic potash, washing out the contents of the body and then treating the body with spirits of wine, chloroform and turpentine. The required surface of the integument I then mounted in gum chloral. Staining was not necessary.

Injected female imagos, second instar females and second instar, prepupal and pupal males were preserved in museum fluid—a 5% solution of formalin in 70% alcohol (using 19 parts 70% alcohol to 1 part of formalin) with 5 c.c. of pure glycerin added to 100 c.c. of this solution.

Second instar, prepupal and pupal males were also mounted by Britten's Method (utilizing glacial acetic acid, clove oil and euparal). Larvae were stained and mounted in picric acid in polyvinyl alcohol, this mountant being an invaluable aid in the discrimination of detail.

Male imagos were fixed in Bles Solution and stored in 70% alcohol, mounted in gum chloral or in picric acid in polyvinyl alcohol, or by Britten's Method. Of these methods of mounting, none was entirely satisfactory; gum chloral was found to over clear; picric acid in polyvinyl alcohol supplanted the natural colouration with its own green colouration; and Britten's Method, though excellent, is laborious.

The life history of the Coccid was first determined from specimens taken at Rottnest Island. Here, in the month of December, it was possible to obtain female specimens in all stages of development, thus revealing the three instars of the female. Two instars of the male were likewise obtained at this time, and the remaining prepupal, pupal and imaginal instars on the 10th of the following February.

Early in October, 1945, larvae were released upon Tuart trees in the grounds of the Department of Biology, Crawley, thus enabling a verification of the previous observations regarding the number of instars made with Rottnest material. Larvae were also released upon a Jarrah (*E. marginata*) tree in the grounds of the Department, in order to determine whether *Apiomorpha egeria* was capable of parasitizing a Eucalypt other than the Tuart. No galls were observed to develop, but this experiment must be regarded as inconclusive, since the larvae were released late in their season (December), and upon an old tree.

IX. ACKNOWLEDGEMENTS.

The author wishes to express his indebtedness and gratitude to Professor G. E. Nicholls and Mr. E. P. Hodgkin for guidance, and to Mr. G. G. Smith for assistance with literature on the Tuart.

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